



Forest Health Protection

Pacific Southwest Region



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To: District Ranger, Big Valley Ranger District, Modoc National Forest

Subject: Review of Donica prescribed fire and tree injury (Report #NE05-12)

At the request of Anne Mileck, Silviculturist, Modoc National Forest, I conducted a field evaluation of a prescribed fire on the Big Valley Ranger District on September 6, 2005. The objective of my visit was to examine various areas within the prescribed fire to assess fire caused injuries to the conifers and address several resource questions posed by District personnel. Of most concern, was the death of large diameter pines following the fire. Anne and I were joined in the field by Dave LeBlanc, Sale Prep. Technician; Don Glenn, Fuels Technician; Bill Schoeppach, Forest Vegetation Manager; John Landoski, Culturist; Keith Bryan, retired Assistant Forest Fire Management Officer/Fire Ecology Fuels Division and Barb Zylstra, Culturist.

The Donica stand (Stand 190) is an eastside pine stand located near Crank Spring, just off of County Road 91, about 12 miles north of Lookout, CA. The stand is primarily ponderosa pine with some juniper and incense cedar. The stand is 34 acres and was masticated with a slash buster during August, 2000. The mastication prescription included the removal of live trees up to 10" DBH, dead trees < 12" DBH and junipers < 18" DBH. Residual basal area ranges from 70 – 170 feet²/acre. Prior to the prescribed fire, there had not been a recorded burn in this stand since 1910. Less than normal precipitation has been recorded in this area since 2001.

Half of the stand (17 acres) was burned by prescribed fire in November, 2002. Flame lengths were around 2 feet high and the burn was described as a cool burn (per Keith Bryan). There was an initial flash that consumed the needle cover followed by smoldering of the masticated material and duff layer. Two trees were killed during the fire. Since that time, several trees have continued to decline and die due to fire injuries, primarily basal cambium kill. There were several groups of trees that were killed over the past few years and have since snapped off creating small openings in the stand.

Beetle Activity

There was some western pine beetle, *Dendroctonus brevicomis*, activity present in the burned and unburned portions of the stand. In addition, woodborers were found in the recent fire killed

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trees and red turpentine beetles, *Dendroctonus valens*, were found in a few of the fire injured declining trees. The most western pine beetle activity was found in the unburned stand where there was a group of 36 ponderosa pine trees that have been killed over the past two years. These trees bordered private property.

Fire injuries

Some of the large, fire injured, pines were declining as evidenced by poor needle retention and thus, thin crowns. Observations of the cambium on several live trees revealed that cambium kill was common throughout the fire area and I anticipate that additional mortality from fire injuries will continue to occur over the next few years.

We examined some existing duff levels around the base of large diameter pines in the unburned unit to determine the level that existed pre-burn around some of the dead and dying large trees in the burn unit. For a 26" DBH tree, we measured 15" of litter and duff, for a 27" DBH tree there was 12" and for a 33.5" DBH tree, we found 14" of duff and litter around the base of tree (Figure 1). In addition, 15 measurements of residual masticated material revealed depths of material from 4 to 19 inches deep on the ground surface (Figure 2). Since the fire was 3 years prior to these measurements, the duff and litter was somewhat less then and the masticated material has likely compacted over time, but these measurements give some indication of the heat and residual time of burning that the trees were subjected to.

Accumulation of litter and duff around large diameter trees has reached unprecedented levels in the eastside pine type as a result of 100+ years of fire exclusion. The unprecedented litter and duff accumulations observed in most western forests are well documented and described by various authors including Sackett et al. (1996), Covington et al. (1997), Sackett and Haase (1998), and Haase and Sackett (1998). Swezy and Agee (1991) stated, "Restoration burns in ponderosa pine stands where 80 years of fire exclusion have allowed duff to increase, especially at the base of large old pines, may result in greater duff consumption and higher soil temperatures than those experienced by trees subject to periodic low-intensity fires where duff layers are much thinner." Several studies have attributed large diameter tree mortality to basal injury caused by duff mound smoldering and bark beetle attacks. Soil temperatures under smoldering duff mounds reached temperatures of 400°C, with temperatures in duff above 100°C



Figure 1. Depth of duff and litter.



Figure 2. Masticated material around base of tree.

for over 16 hours, compared to soil temperatures of less than 80 °C and duff temperatures above 100 °C for 1 hour under burning slash (Hartford and Frandsen 1992).

Ryan and Frandsen (1991) measured duff mounds around 19 mature ponderosa pine trees in a stand that had not burned for 69 years. The duff depth in their study ranged from 1 to 15 inches. They recorded temperatures in these smoldering duff mounds above 300°C for 2-4 hours during the prescribed burn in Glacier National Park. This resulted in mortality of 45% of the cambium samples. From their data they developed a model using depth of duff burned to determine the probability of fire caused cambium mortality for ponderosa pine. For 8 inches of duff, the probability of cambium mortality is 55%, for 10 inches it is 70% and for 12 inches of duff, the probability of cambium kill is 82%. Using the model developed by Ryan and Fransen, the predicted mortality at Donica based on our duff measurements, where we found 12 – 15 inches of duff and litter around larger trees, the probability of cambium kill would be greater than 80%. Depending upon how much masticated material was near the base of the trees, this additional fuel would also increase the potential for cambium kill.

Monitoring

Anne Mileck requested that Forest Health Protection staff set up the Donica burn as a study site to monitor the tree mortality attributed to the prescribed fire. On September 7, 2005, I returned to the stand to complete a survey and record all mortality in the burned and unburned portions. I classified the mortality into four classes – 1) fading crown; 2) dead crown with needles (tree death within past year); 3) dead tree with no needles (tree death 2 - 3 years ago) and 4) down (in most cases broken off < 3 ft. from ground line). Determining the year of tree death by needle retention is somewhat arbitrary, as it can vary greatly, but for the purposes of this report the above classification is suitable. In the burned unit I recorded a total of 401 dead trees (Figure 3) compared to 48 (36 were in a group killed by western pine beetle) in the unburned unit (Figure 4). The majority (90%) of the trees killed by fire were ≤ 15" DBH. There were 7 fire killed trees that were ≥ 26" DBH, with 2 of those being over 30" DBH.

Figure 3. Number of trees killed by fire by diameter class in the Donica stand.

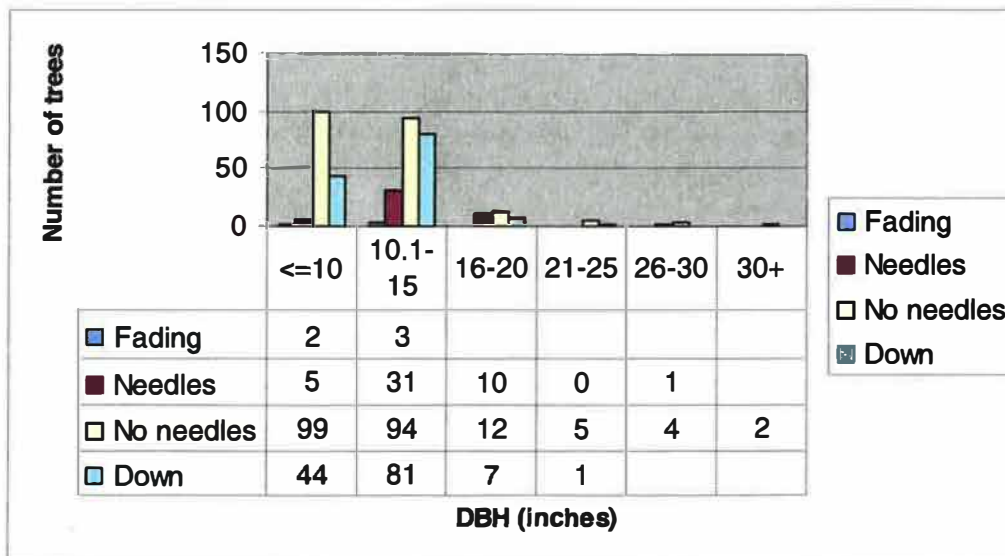
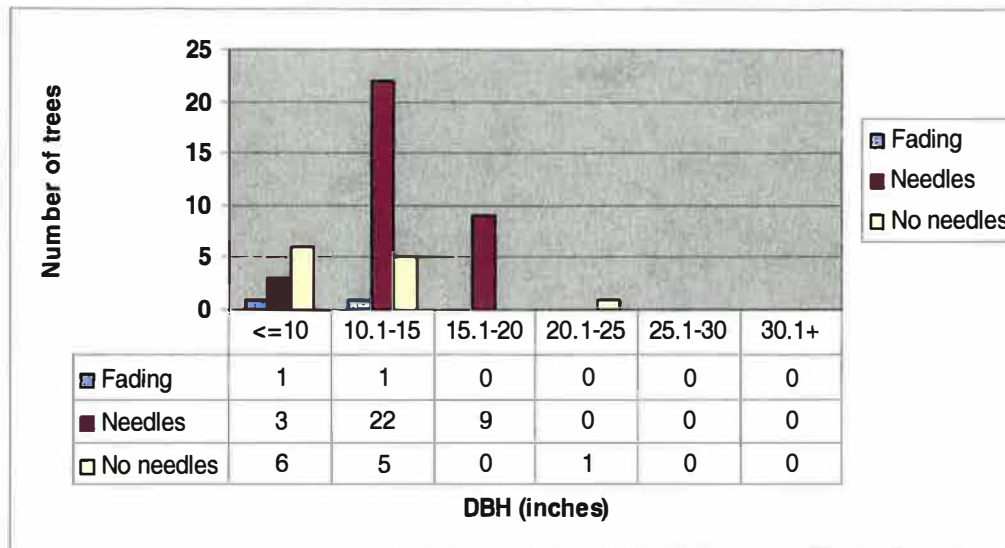


Figure 4. Number of trees killed in the unburned Donica stand, mostly by western pine beetle.



Discussion

Fire injury can be in the form of crown kill or scorch, cambium kill and root kill. Tree mortality can occur from a single type of injury such as crown kill or when injuries are combined, such as cambium kill and crown kill. Crown injury was minimal in the Donica burn, however, it appears that many trees sustained levels of cambium kill that have resulted in tree death since the 2002 prescribed fire. Trees have been additionally water stressed by below normal precipitation over the past several years. Based on the number of trees killed, it is likely that the mortality level has surpassed the level acceptable in the burn plan. Mortality is declining annually and should continue to do so, however, some additional mortality should be expected in the trees exhibiting thin crowns.

If land management objectives include maintaining large, live pine trees on the landscape, it is recommended that duff, litter, brush and residual logging or masticated material be removed prior to prescribe burning. Removal should occur out to about 2 feet from around the base of the tree with the removed material being broadcast around. Preventing burning around the trees through the use of fire lines or foaming is also an option, but removal of the material is preferred to provide protection both during prescribed and wildfires.

I will continue to monitor the Donica stand annually and will provide updates as appropriate. Please feel free to call me at 530-252-6667 or email ssmith@fs.fed.us if you have more questions or need to request additional assistance in the field.

/s/ *Sheri Lee Smith*

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